Magnetic resonance imaging of cranial nerves at 7 Tesla

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Introduction:

Aim of this study was to prove the feasibility of cranial nerve (CN) imaging with 7 Tesla MRI. On the one hand, due to an increased SNR and a higher spatial resolution with increasing magnetic field strengths, a high detection rate for small anatomical structures such as the CNs is expected. On the other hand, due to more pronounced susceptibility effects, a reduction in imaging quality could be assumed.

Methods:

Four consecutive volunteers were examined with a 7 Tesla whole-body scanner (Magnetom 7T, Siemens Healthcare, Germany) and a custom-built 8-channel transmit / receive head coil [1]. Four sequences, optimized for this study at 7 Tesla, were evaluated: a 3D-MPRAGE (TR = 3500, TE = 4.17, TA = 22:19, FA = 7, voxel size = 0.5 x 0.5), a 3D-CISS (TR = 6.51, TE = 3.26, TA = 10:34, FA = 19, voxel size = 0.47 x 0.47), a 3D-TrueFISP (TR = 7.86, TE = 3.93, TA = 5:26, FA = 25, voxel size = 0.35 x 0.35) and a 2D-T2-TSE (TR = 6000, TE = 74, TA = 4:24, FA = 130, voxel size = 0.5 x 0.5) sequence. Due to vendor limitations, no parallel imaging could be performed in the CISS. CNs II to XII were evaluated. The identification rate was evaluated with a previously established three-point scale [2]; furthermore the presence of artifacts or other imaging limitations was described.

Results and Discussion:

In all sequences, especially the small CNs were not always easily to differentiate from small blood vessels. TrueFISP, although suffering from severe banding artifacts despite intensive B0 shimming prior to acquisition, provided the best identification rate; 83% of the nerves could be identified with certainty in this sequence, whereas only 62% could be identified in the CISS and the MPRAGE, and 42% in the T2-TSE (Fig. 1). MPRAGE provided little contrast between CNs and CSF in some areas, and CISS suffered from susceptibility and pulsation artifacts. T2-TSE was especially not able to display small CNs (Fig. 2). As parallel imaging was not possible in the CISS sequence, which presents the “gold standard” at lower magnetic field strengths, a higher resolution could be achieved in the TrueFISP sequence while keeping the acquisition time reasonable.

Conclusion:

7 Tesla MRI is feasible for CN visualization. The TrueFISP sequence seems to be advantageous at the moment. The present study displays an important basis for further clinical applications of 7 Tesla cranial nerve imaging, i.e. for imaging of tumors, inflammations or nerve vessel contacts.

References:

1. Orzada S, Kraff O, Schäfer LC, et al. 8-channel transmit/receive head coil for 7 T human imaging using intrinsically decoupled strip line elements with meanders. Paper presented at: ISMRM 17th Scientific Meeting & Exhibition; 18 - 24 April, 2009; Honolulu, Hawaii.
2. Yousry I, Camelio S, Schmid UD, et al. Visualization of cranial nerves I-XII: value of 3D CISS and T2-weighted FSE sequences. *Eur Radiol.* 2000;10:1061-1067.

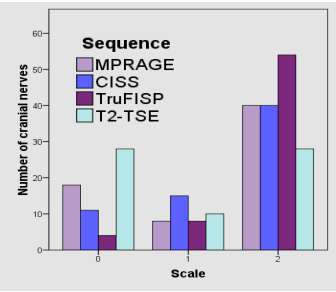

Fig. 1: Cranial nerve evaluation:
TrueFISP provided the most “identifications with certainty” = 2, T2-TSE most “no identifications” = 0.

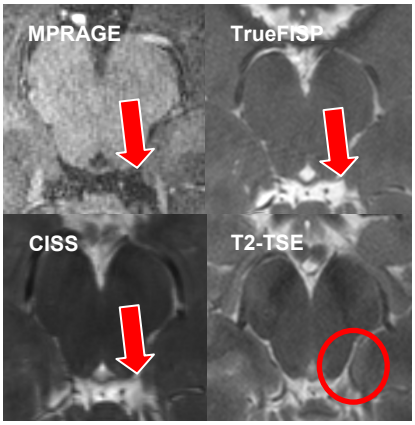

Fig. 2: Imaging examples for the cranial nerve IV:
MPRAGE provided little contrast between CNs and CSF. CISS suffered from pulsation artifacts in this area. T2-TSE was not able to display the small trochlear nerve. Best visualization was possible with the TrueFISP sequence.